NDIA Guns & Ammunition Symposium 2004

Munitions safety and effectiveness research in the Netherlands

TNO Prins Maurits Laboratory

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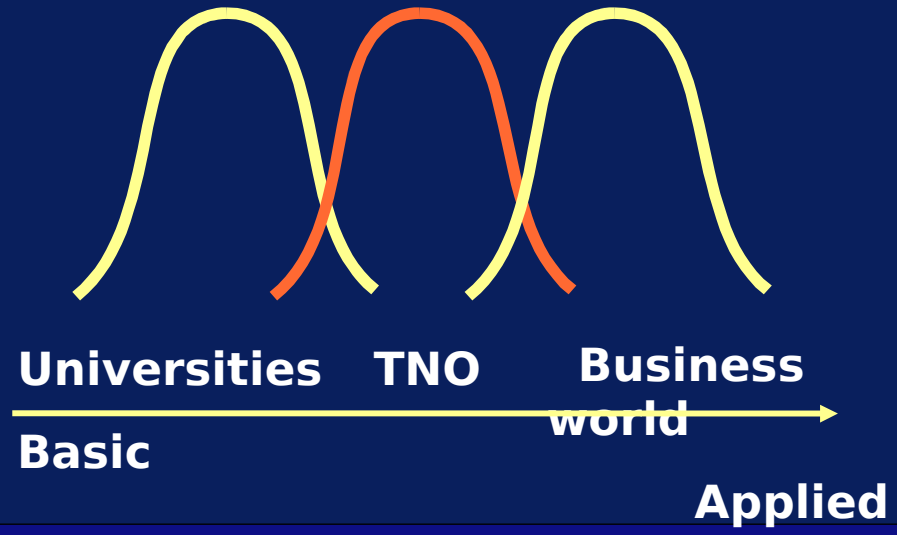
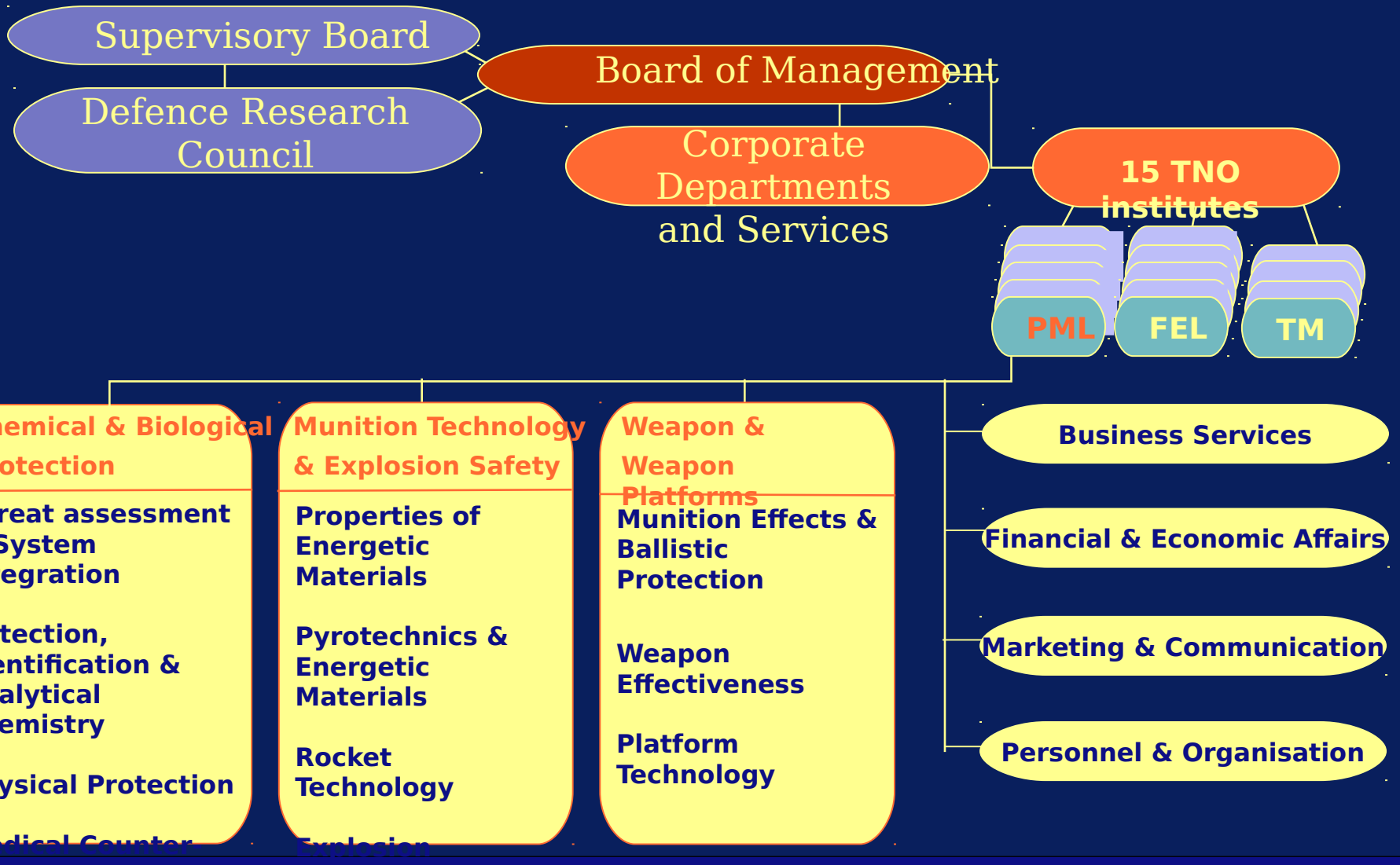
The Netherlands organisation for applied scientific research TNO

- … positioned between university and business
- … an independent governing body
- … established by law in 1932
- … 5.500 professionals
- … 472 M€ turnover (2003)
- … 15 institutes



TNO Defence Research



TNO Defence Research
Three Institutes

- **TNO Physics and Electronics Laboratory**
  - Operations Research & Business Management
  - Command & Control and Simulation
  - Electronics & Electronic Warfare
  - Observation Systems

- **TNO Prins Maurits Laboratory**
  - Chemical & Biological Protection
  - Munition Technology & Explosion Safety
  - Weapons & Weapon Platforms

- **TNO Human Factors**
  - Perception
  - Information Processing
  - Work Environment
  - Group Work
  - Skilled Behaviour
  - Training and Instruction

Munitions Effectiveness

- **Customers**
  - Netherlands Armed Forces
  - Foreign government (Defense)
  - Defense industry
- **Research activities**
  - Munitions performance
  - Target modelling
  - Engagement analysis
- **Applications**
  - Threat analysis
  - Procurement support
  - Development support

Indoor test facility for Ballistic Research

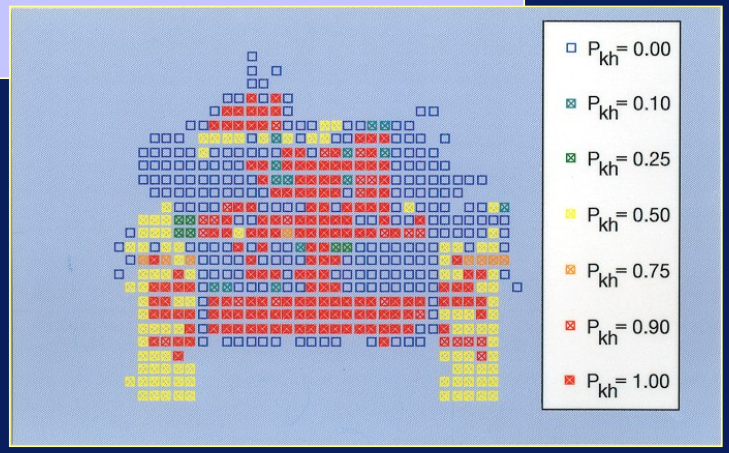
LBO Ypenburg

- Large calibre firing range (40 mm KE, 76 mm HE)
- Two small calibre firing ranges (20 mm KE)
- Explosion bunker (25 kg HE)

TARVAC Vulnerability Assessment Code

- **Target Modelling (BRL-CAD)**
  - Geometry
  - Materials, construction
  - Functions
  - Systems

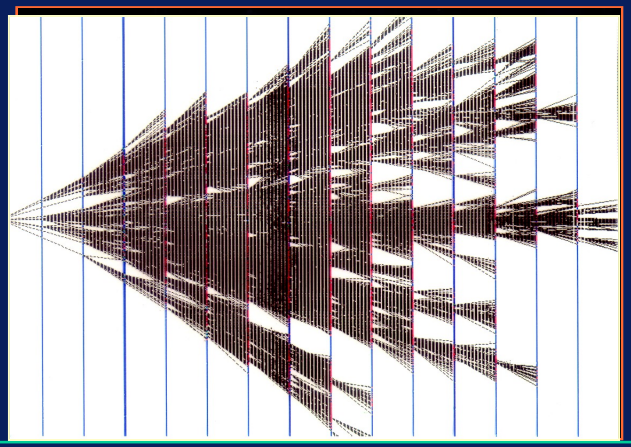
- **Munition Analysis**
  - Flight behaviour, hit accuracy
  - Penetration and perforation
  - Fragmentation characteristics
- **Postprocessing**
  - Vulnerability/lethality plots



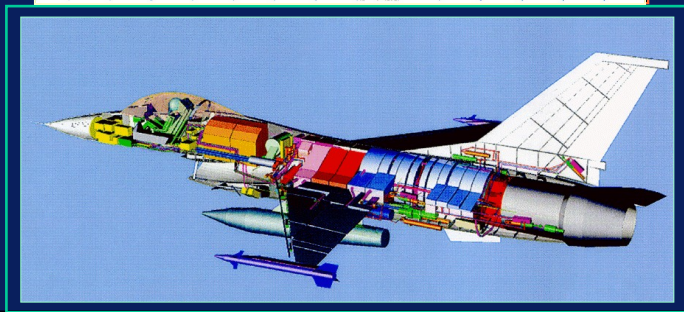
Fragmenting payload munitions

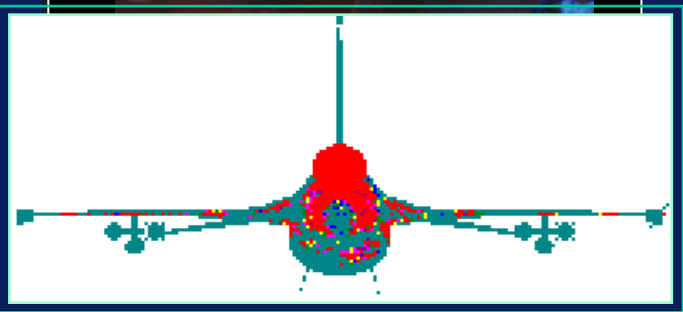
- **Based on many years of experience in performing firing trials and lethality simulations against air- and ground targets, TNO has a unique capability to evaluate and develop specific ammunitions, like fragmenting payload ammunition**

Terminal ballistics



Lethality simulations





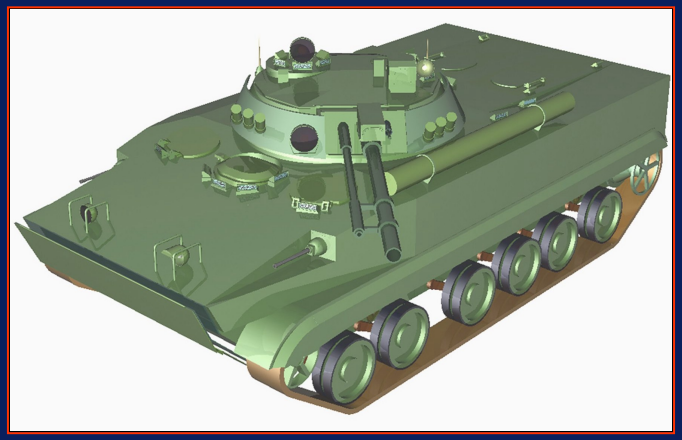
Firing trials against Helicopter

(Burst of 3 FAPDS projectiles against cockpit)

Note: no explosives in the projectiles!

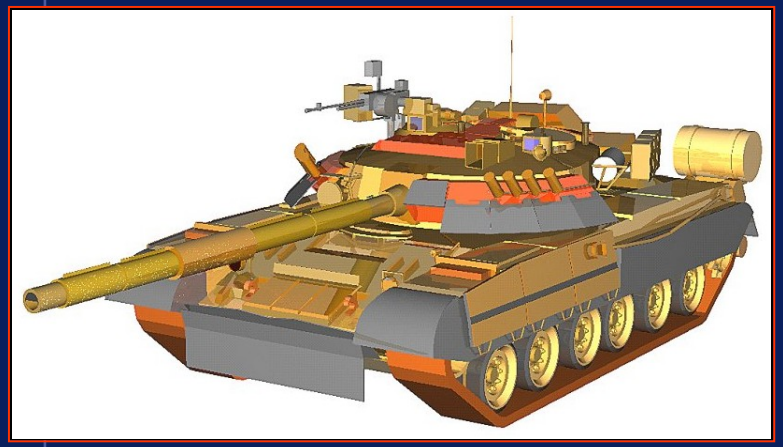
Calibre choice for the future IFV

30 mm vs 35 mm



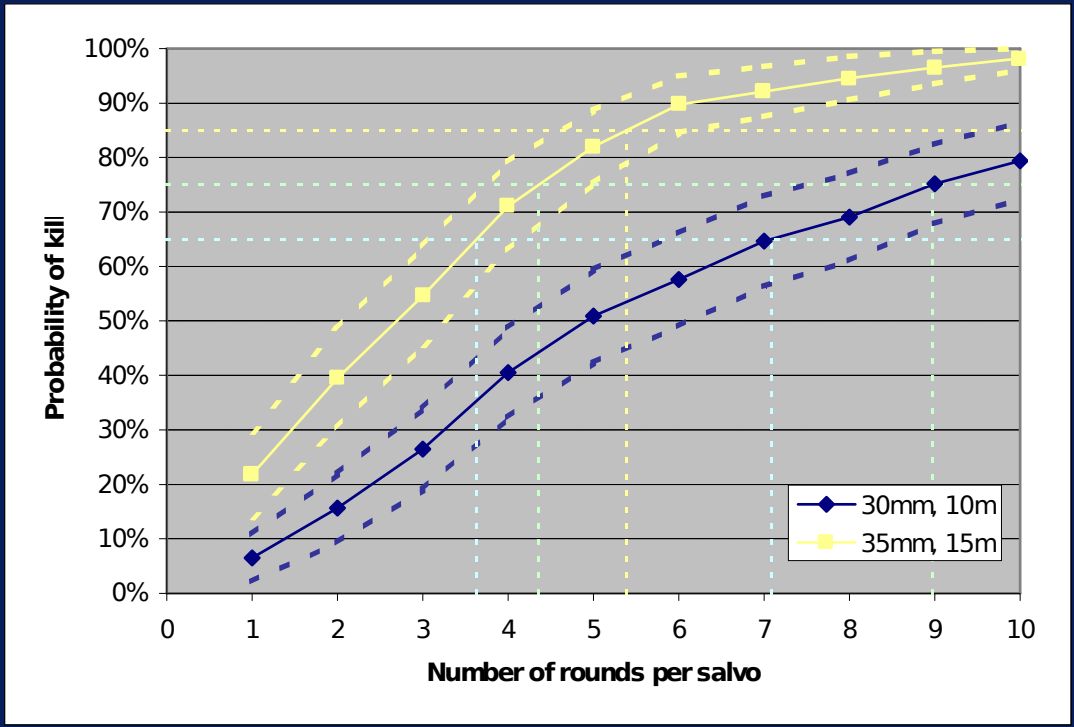
APFSDS vs BMP-3
Firepower kill

ABM vs T-80U
Firepower kill (sights)



ABM vs 2-man covered foxhole
Personnel kill

ABM versus personnel in a two-man covered foxhole



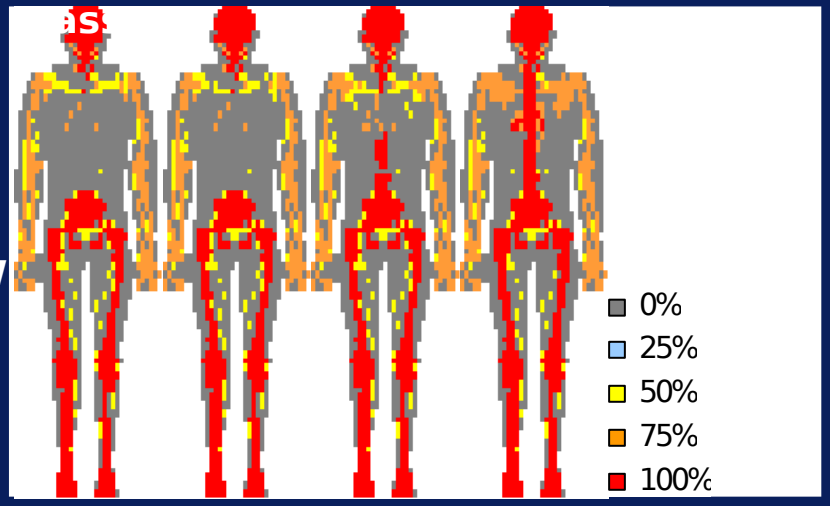
- Compared to 35 mm, over twice as much 30 mm rounds must be used to get the same result
- Explained by the larger number of subprojectiles

ABM subprojectile lethality

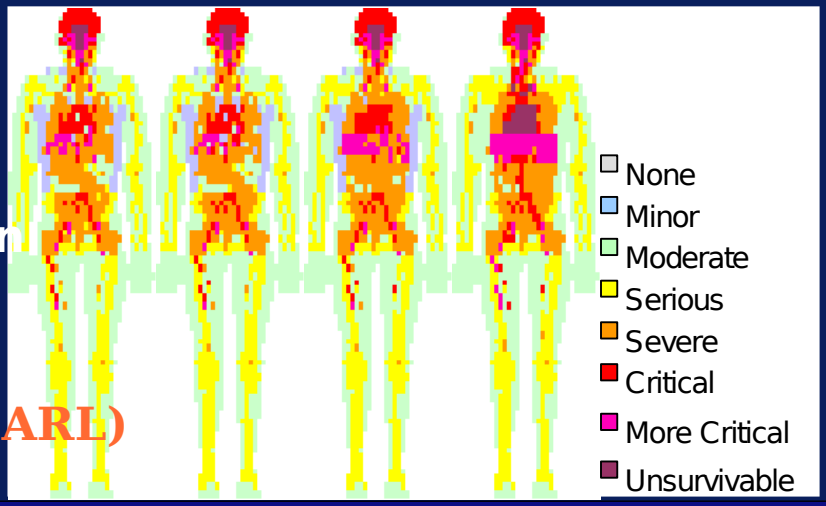
- 450 m/s impact velocity
- Standing soldier
- With helmet and vest
- 30. sec assault

Increasing Subprojectile

Pk view



Injury indication view



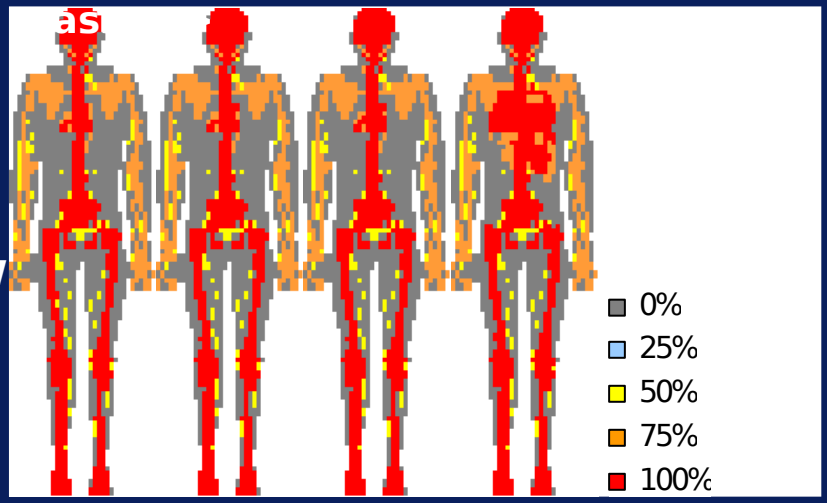
Calculated with Computerman (ARL)

ABM subprojectile lethality

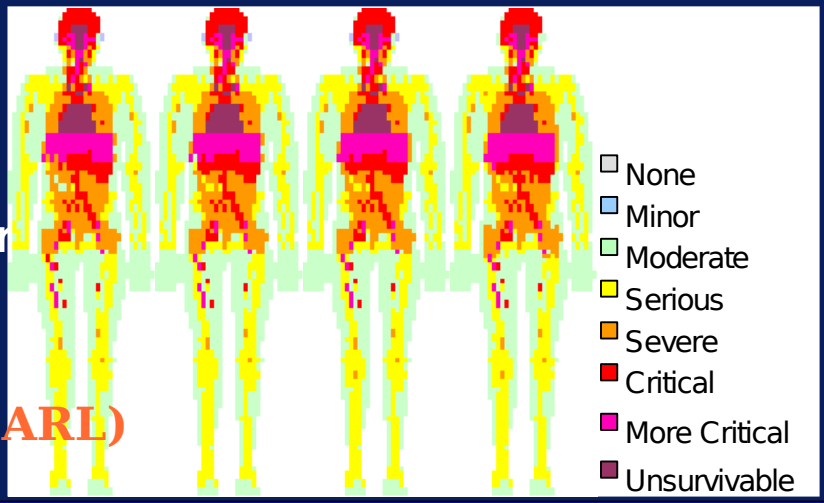
- 900 m/s impact velocity
- Standing soldier
- With helmet and vest
- 30. sec assault

Increasing Subprojectile

Pk view



Injury indication view



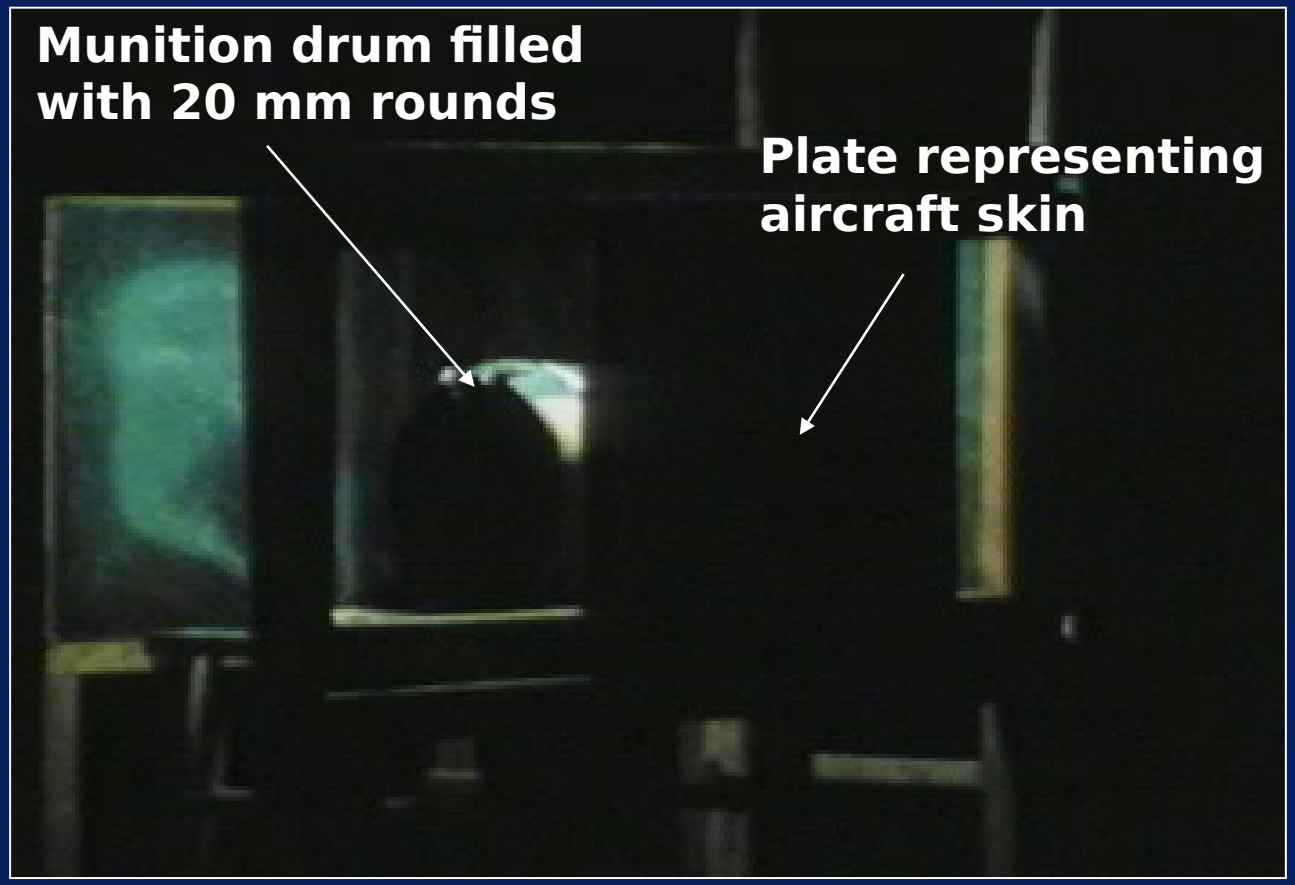
Calculated with Computerman (ARL)

...Followed by consequence analysis

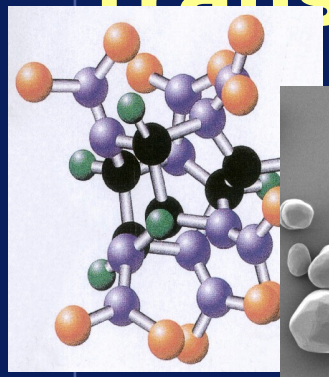
- **Benefits of having a single round**
  - Operational flexibility
  - Stowed kills
  - Logistics
  - Train as you fight

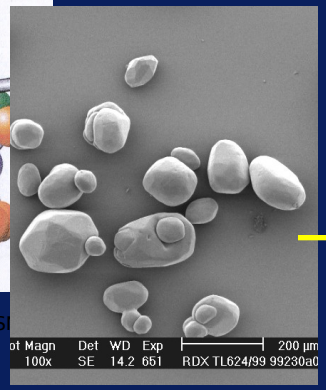
Firing trials against Aircraft

(FAPDS against ammunition drum filled with 40 20 mm rounds)



Munitions safety chain for operational use, storage and transport





Properties of EM

Properties of the composite

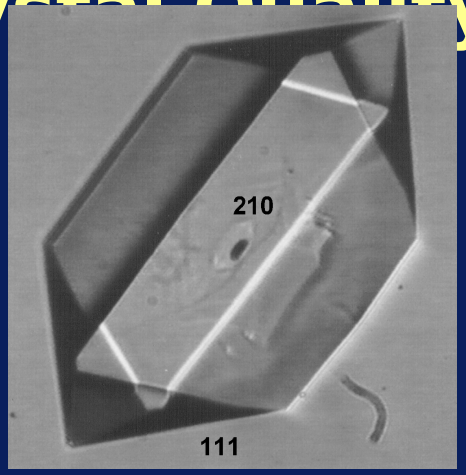
Properties of the Munition item

Properties of the storage layout and barriers

Properties of the storage/transpor
stockpile

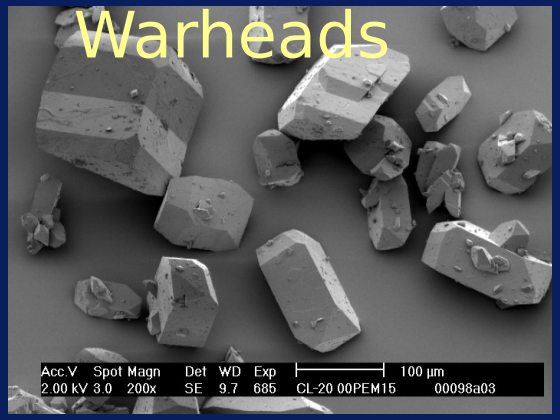
I Energetic Material properties; Improved Crystal Quality

RDX

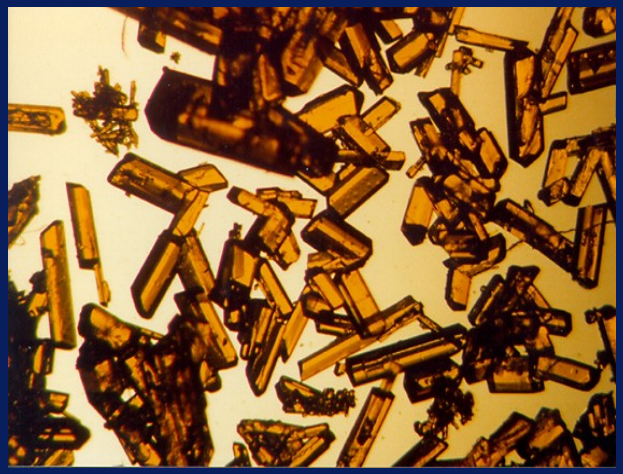


Insensitive crystals for HE Warheads

CL-20



HNF

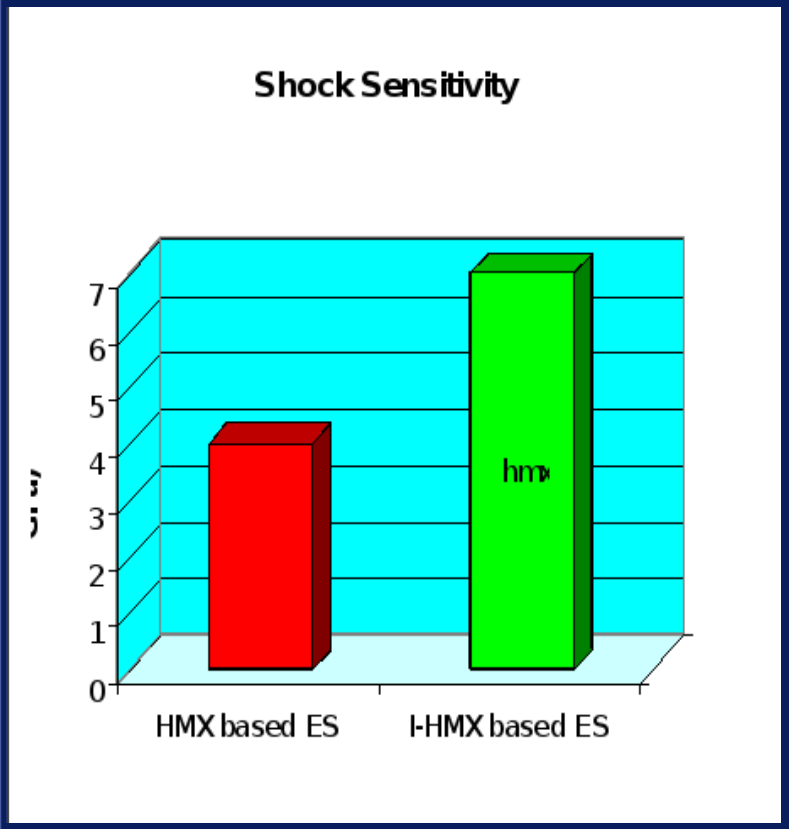


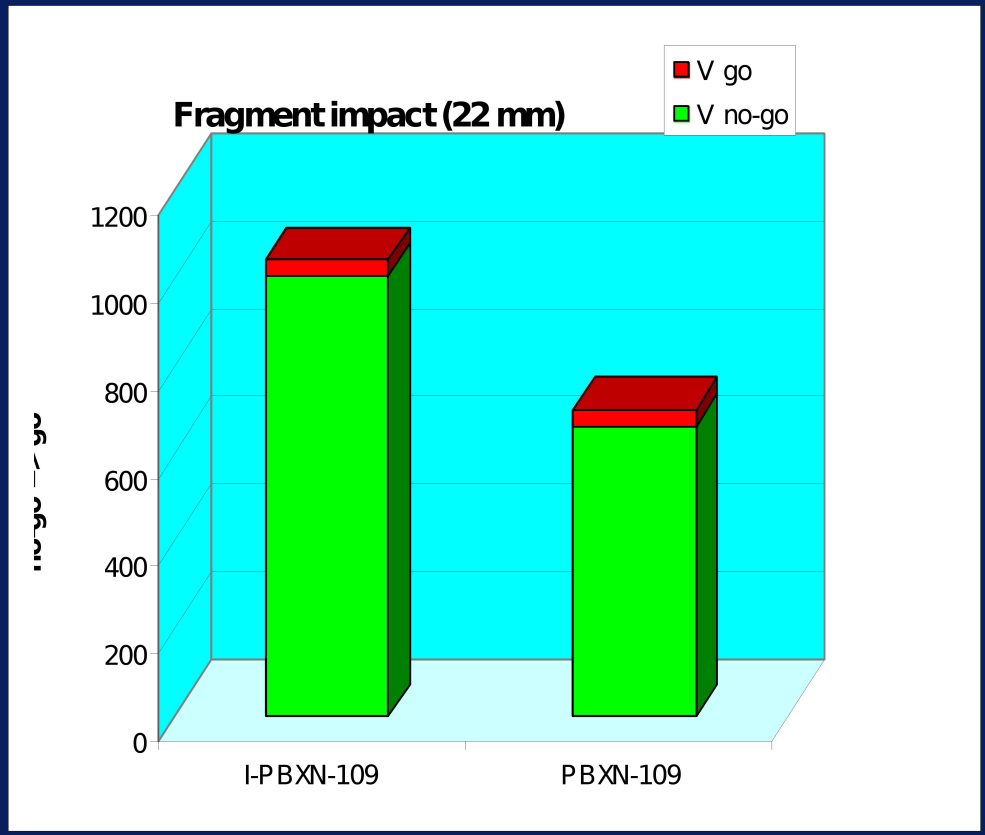
Insensitive crystals for propellants

HNS-IV

Insensitive crystals for Booster Explosives

I Improved insensitivity due to better quality of the crystals

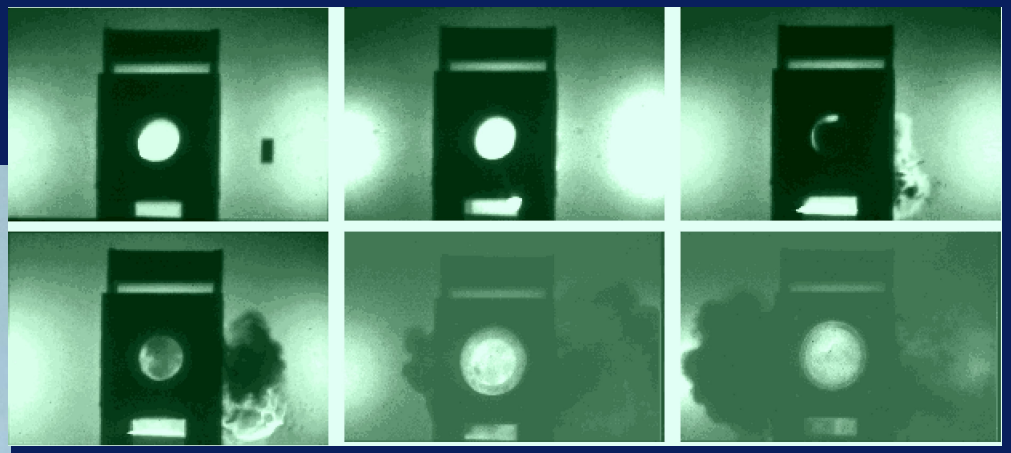




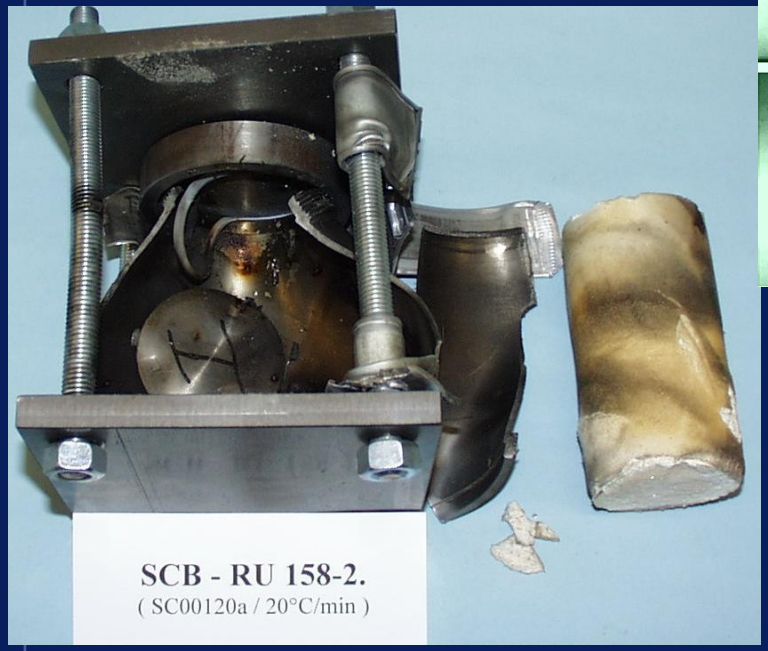
HMX-based PBX

I-PBXN-109 Vs PBXN-109

II Properties of Composite; IM due to Insensitive explosive compositions



Fragment Impact

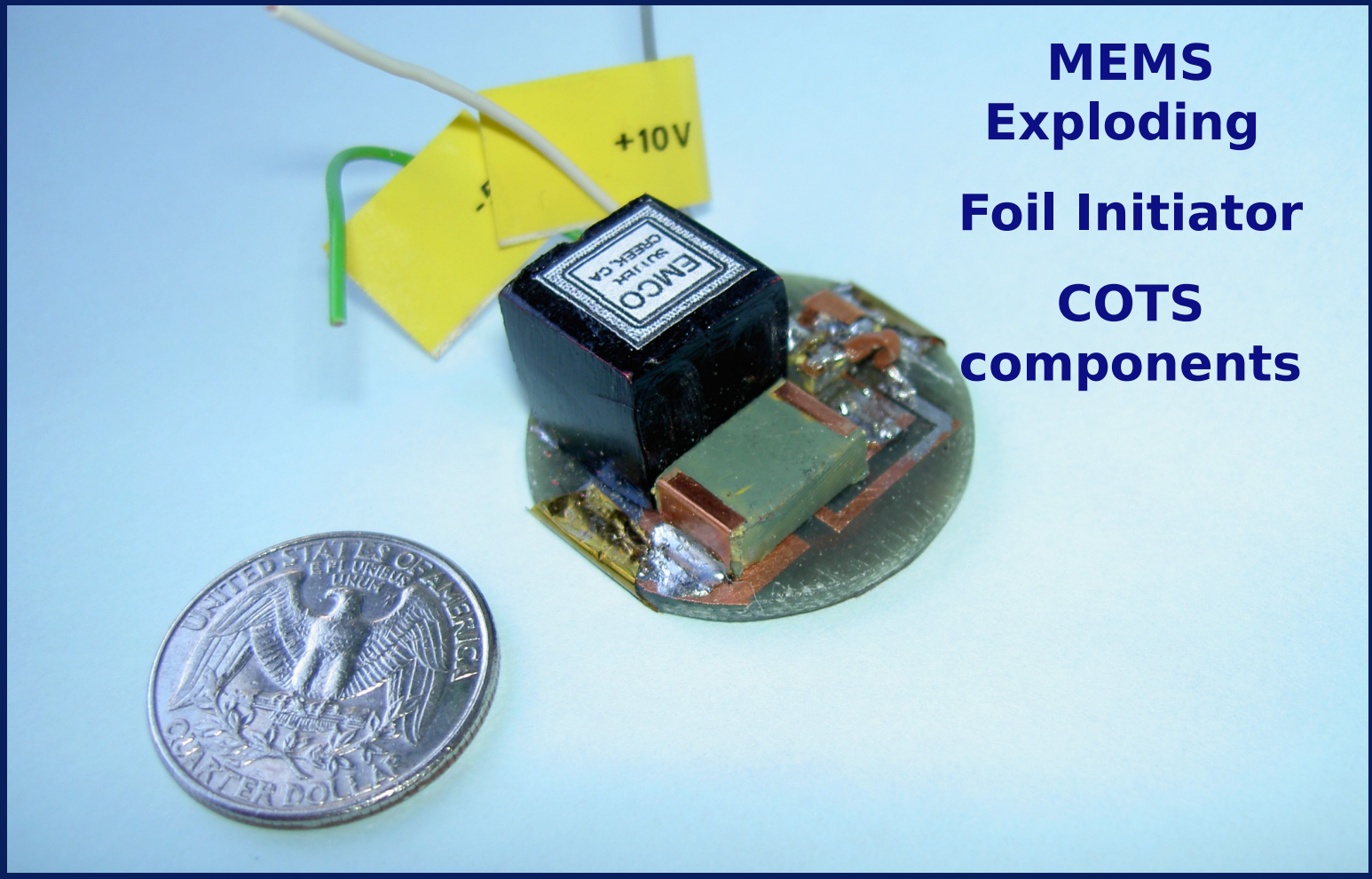


Cook-off

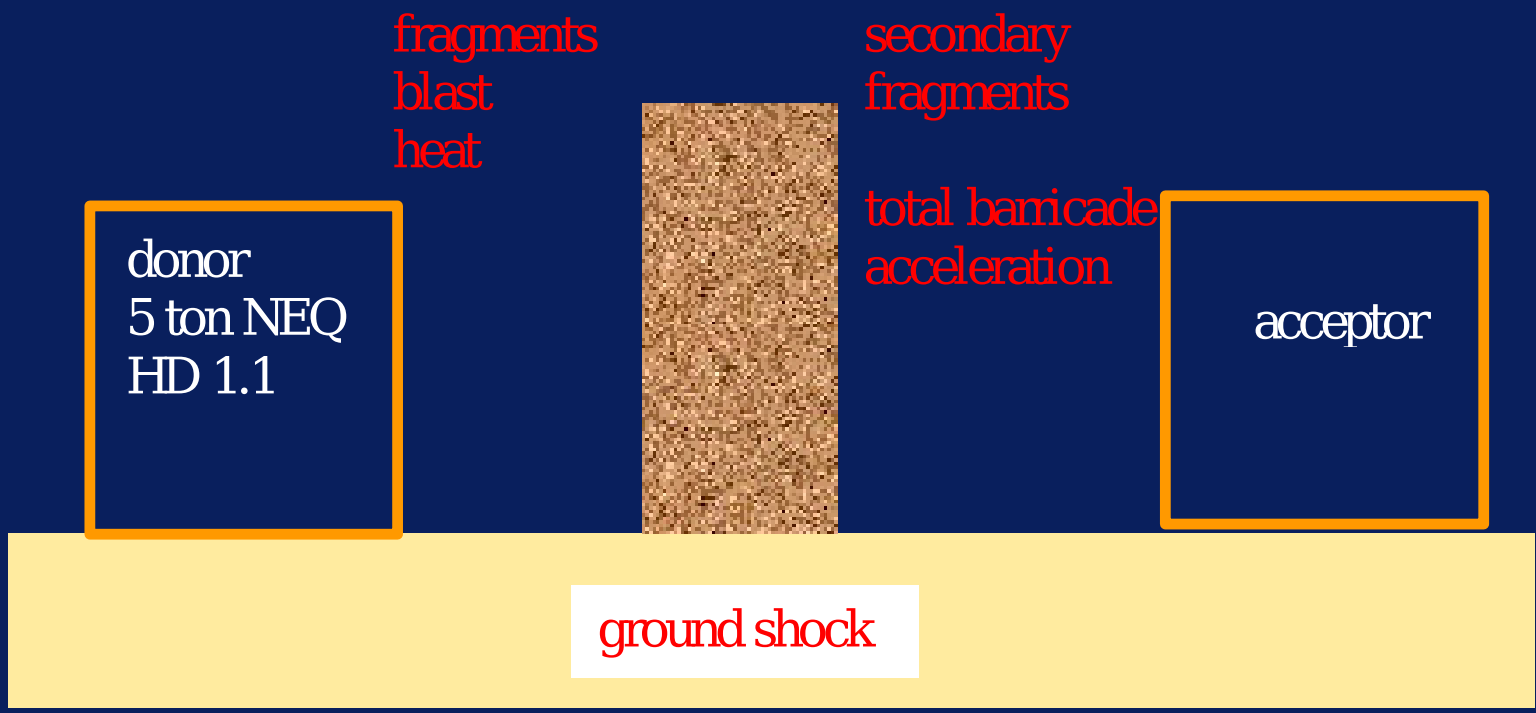
II Properties of Composite; LOVA Propellants

Extruded composite gun propellants
for Long-range Ammunition

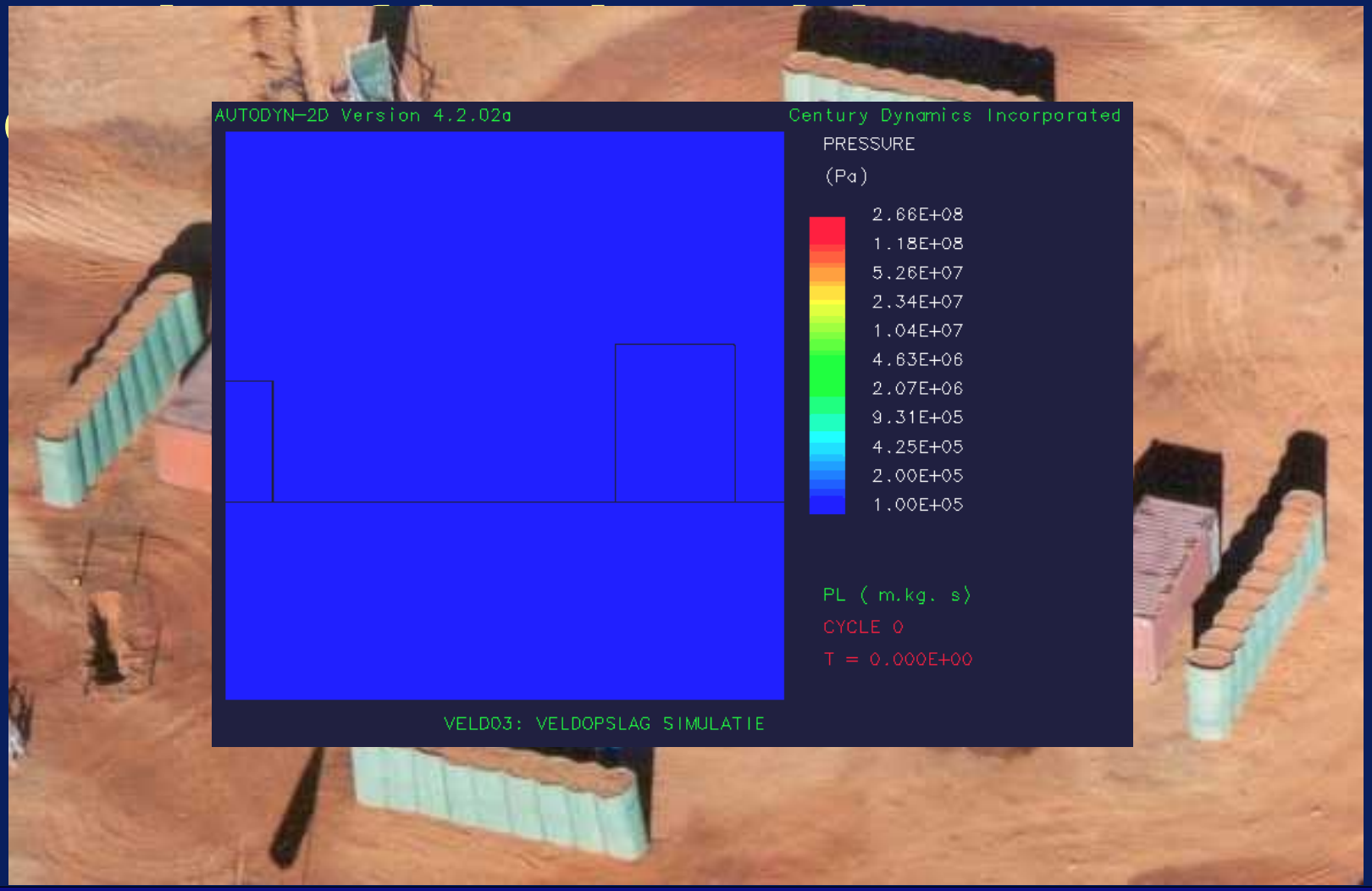
III System properties; Intrinsic Insensitivity due to MEMS Technology



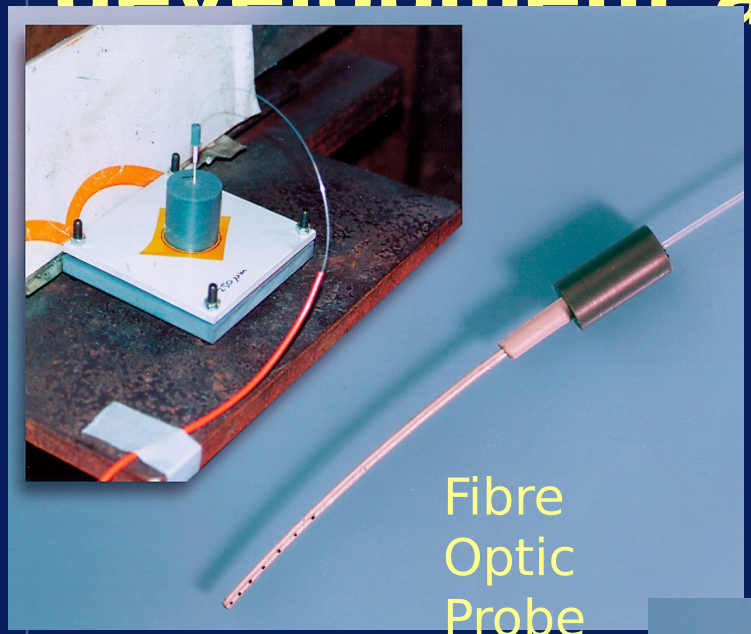
IV and V Barrier design and storage layout;
Design of proper barricade to prevent from sympathetic detonation



IV and V Barrier design/storage layout;

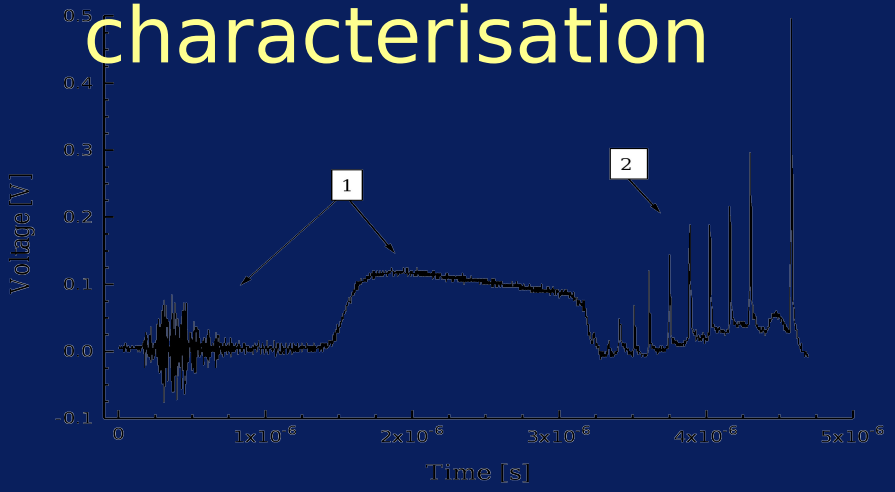


Other activities on (IM) munition development at TNO-PML

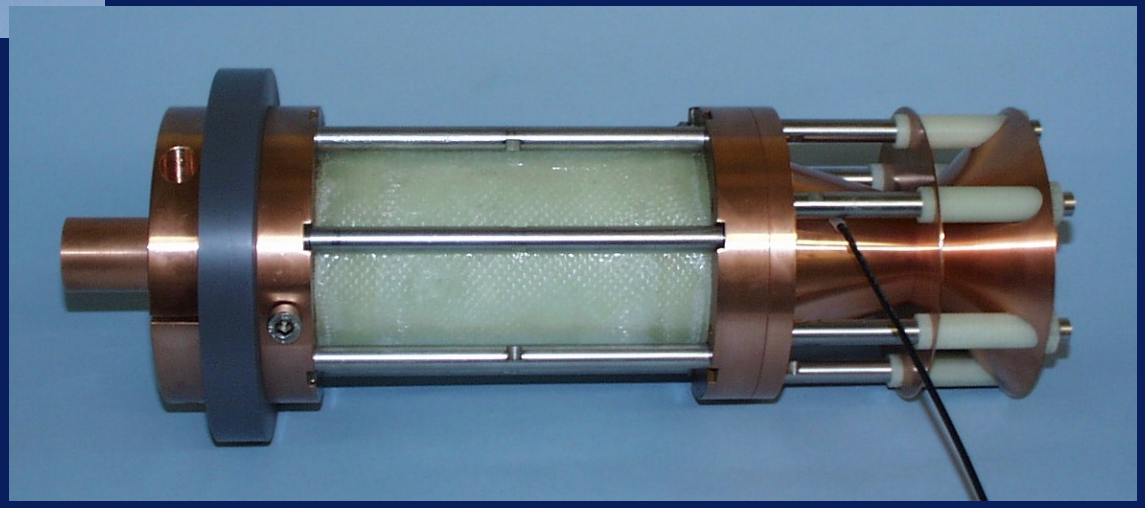


Fibre Optic Probe

Material characterisation



Development of HPM Munitions



Summary

- **TNO is an independent organization**
- **Research dedicated to safe and effective munitions**

- **Government asks TNO for testing, evaluation and analysis**
- **industry asks TNO for testing, evaluation and co-development**

TNO: committed to an effective force